# Report for 2002CO6B: Evaluating Strategies to Mitigate Waterlogging and Salinization in Colorado's Lower Arkansas River Valley, Phase 3

- Other Publications:
  - Burkhalter, J.P., and T.K. Gates, 2005, "Evaluating regional solutions to salinization and waterlogging in an irrigated river valley," Journal of Irrigation and Drainage Engineering, ASCE, 131: In press.
  - Burkhalter, J.P., and T.K. Gates, 2005, "Agroecological impacts from salinization and waterlogging in an irrigated river valley," Journal of Irrigation and Drainage Engineering, ASCE, 131 (2): In press.
  - Chiang, P., and T.K. Gates, 2004, "Strategic river water quality planning using calibrated stochastic simulation," Journal of Water Resources Planning and Management, ASCE, 130(3), 215-231.

Report Follows

## Problem and research objectives:

For more than a hundred years, vast canal systems made up of more than 1000 miles of channels, have diverted and distributed the waters of the Arkansas River to thirsty, yet fertile alluvial soils in southeastern Colorado. Irrigation has made possible productive agricultural economies and scenic rural landscapes in the valley, but not without exacting a cost. Over the years, while the benefits of an impressive irrigation infrastructure were obvious, an insidious side effect was slow taking form. The groundwater table has been rising and growing more saline due to excessive irrigation, seepage from earthen canals, and inadequate drainage facilities.

Anecdotal evidence of irrigation-related problems in the Arkansas River Valley has been ample. Only recently, however, have researchers focused on accurately diagnosing these problems and systematically searching for viable solutions.

Development and evaluation of management strategies to reduce waterlogging and salinization problems in the Lower Arkansas Valley is the goal of this project. Strategies to be considered alone and in combinations include:

- Increased irrigation efficiency
- Reduced seepage from irrigation canals
- Increased pumping rates from existing pumping wells with excess flows (above legal permit) routed through drains to the river
- Installation of horizontal subsurface drains
- Lowering of water surface elevation along the river
- Conversion to more salt-tolerant crop varieties

## Methodology:

Utilizing data from on-going projects, input from stakeholders, and extant field-scale models, various strategies will be modeled to determine viable solutions which address all aspects of the nature and variability of the Arkansas River and its tributaries, the reservoirs, and the groundwater aquifer within the lower river valley as well as information on the soils, crops, and irrigation and drainage system serving the valley.

Since 1999, a data set has been gathered in a region selected to be representative of hydrogeologic and agronomic conditions upstream of John Martin Reservoir (see figure 1). Within the study region, there are six major irrigation canals, numerous smaller irrigation and drainage ditches, eight tributary drainages, three main reservoirs, and over 280 active pumping wells. Major irrigation canals are allocated water based on prior-appropriation water rights. Cultivated crops include alfalfa, corn, grass, wheat, sorghum, cantaloupe, watermelon, and onions. The most common irrigation methods in the area are furrow irrigation and border irrigation using open ditches with siphon tubes or, in some cases, gated pipe. Less than five percent of the region is irrigated with sprinkler and drip irrigation systems.

Investigations in this study region include ground water monitoring, well installation and observation, surface water salinity measurements, intensive soil salinity monitoring, topographic and hydrographic surveying using differential global positioning systems (GPS), measurement of soil and aquifer properties, measurement of seepage from irrigation canals, measurement of irrigation applications and runoff, measurements of crop yield, and other related activities.

**Principal findings and significance:**

MODSIMQ has been augmented with the data collected to produce regional, basin, and field-scale models, which allow analysis of various strategies for dealing with the water salinity issues. Preliminary calculations predict that revenue lost to waterlogging and salinity in the Upstream study region is approximately $94/acre over April 1999 to October 2001. The model systems will be further calibrated and enhanced and then used to test various scenarios for managing the water quality issues in the area.